Nocturnal Habitat Use by Juvenile Chinook in Nearshore Areas of South Lake Washington

a Preliminary Investigation

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Abstract

Puget Sound chinook salmon (*Oncorhynchus tshawytscha*) have recently been listed as threatened under the Endangered Species Act. Historically, the Cedar River, as part of the Duwamish watershed, supported indigenous chinook salmon. In 1912, the Cedar River was diverted into southern Lake Washington, altering migration routes and environment conditions fish were exposed to. Chinook salmon rarely occur in lakes, and little is known of their habitat use in lakes. Lake Washington is a highly altered environment with extensive development along the shoreline. Juvenile chinook salmon are found in the lake between January and July, primarily in the littoral zone (K. Fresh, WDFW, these proceedings). We snorkeled nearshore areas of southern Lake Washington for juvenile chinook salmon during winter and spring, 2000, to evaluate our sampling technique and provide preliminary information on nocturnal habitat use relative to shoreline development.

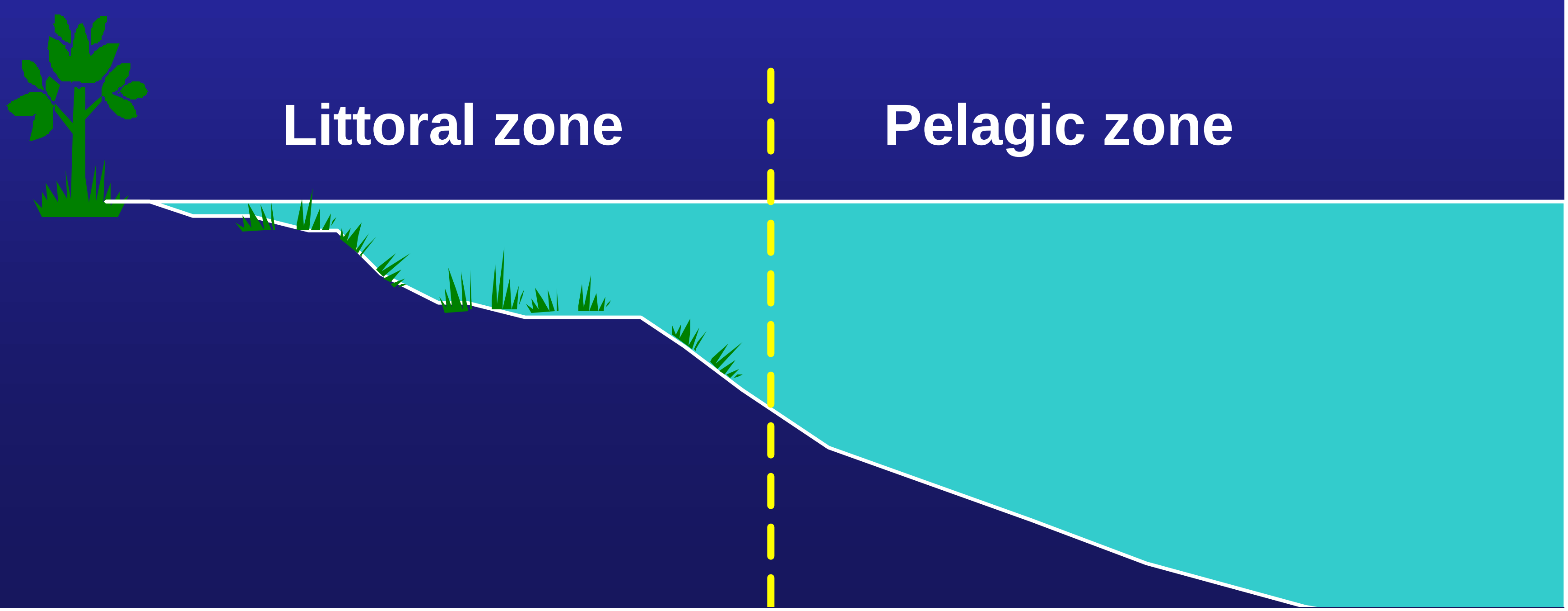
Nighttime snorkeling was an effective method to observe chinook salmon in nearshore areas <1m deep. Snorkelers could easily locate, approach and identify chinook salmon, and mark their locations accurately for microhabitat measurements. Nocturnal distributions of juvenile chinook salmon were related to slope, substrate, and depth. We observed the highest densities of juvenile chinook salmon along the shallowest depth contour surveyed (0.4 m compared to 0.7 m), in areas with small to fine substrate (< 50 mm), and in areas having a gradual slope. Overhead cover appeared to be avoided, but we cannot determine its importance at this time due to confounding factors (e.g. slope and substrate) of variables found beneath these structures. Based on their distribution relative to piscivorus fishes, we believe juvenile chinook salmon in Lake Washington are selecting nearshore habitats according to substrate- and depth- dependent risk of predation. Although further study is needed, these data suggest some shoreline development activities (e.g. riprapping, creating steep and/or deep shorelines with bulkheading, and building overhead structures) create habitat avoided by juvenile chinook salmon at night. We plan to expand this study in 2001 by increasing the survey effort (especially the use of overhead structures and shoreline armoring), survey other habitats and areas of the lake (including tributary mouths, vegetated areas, large wood, mid- Lake Washington, and Ship Canal), begin an investigation of daytime habitat use, and possibly experimentally testing the use of overhead structures and vegetation by juvenile chinook salmon.

Juvenile Chinook Salmon

- Chinook naturally distribute in large rivers and coastal streams, including the historic Cedar River.
- Chinook salmon rarely occur in lakes, and little is known of their habitat use in lakes.
- In 1912, the Cedar River was diverted into Lake Washington. Chinook occurring in Cedar River and greater Lake Washington system must migrate through the lake.
- Presently, the largest wild population of chinook in Cedar River
- Two groups of migrants from Cedar River:
  - early group as fry (January-March)
  - later group of larger juveniles (May-July)
- Both groups outmigrate to Puget Sound in June and July

Juvenile Chinook Salmon

- May inhabit Lake WA for up to 5-6 months beginning in January
- Primarily found in littoral zone (K. Fresh, WDFW).

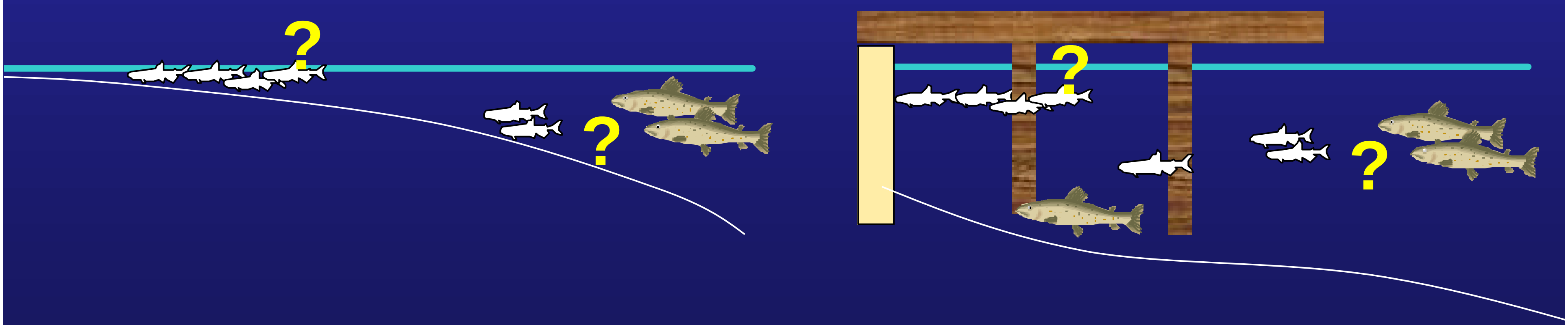


Lake Washington shoreline

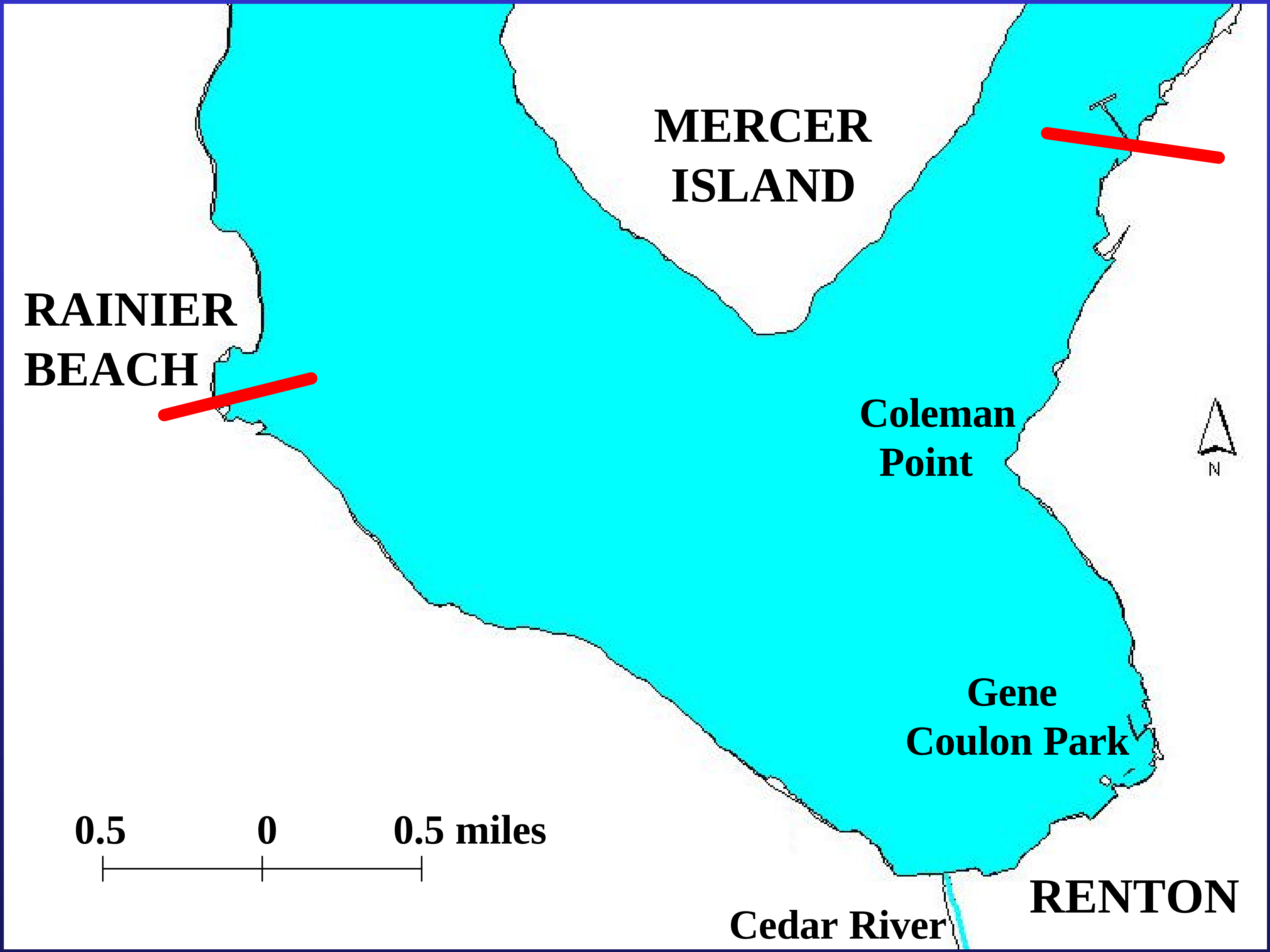
- Mostly residential property with private docks
- Banks extensively rip-rapped or bulkheaded

Study Objectives

- Evaluate sampling techniques
- Document nocturnal habitat use
- Determine relationship between habitat use and shoreline development



Study Area: South Lake Washington



Methods

Nighttime snorkeling:

- **If slope low-moderate:** **two snorkelers, 0.4 and 0.7 m depth contour**
- **If slope steep:** **one snorkeler, along shoreline**
- **Identified and counted fish species observed**
- **Flagged locations of chinook to subsample microhabitat variables, which included:**
  - ***Depth***
  - ***Distance to shore***
  - ***Dominate substrate***
  - ***Type and distance to cover***

Methods

General site measurements included:

- **Substrate**
- **Shoreline Armoring**
- **Slope**
- **Overhead structures**

Results

- Completed 41 snorkel surveys at 35 sites between February and June, 2000
- Average site length = 67 m
- Site length range: 28 - 145 m

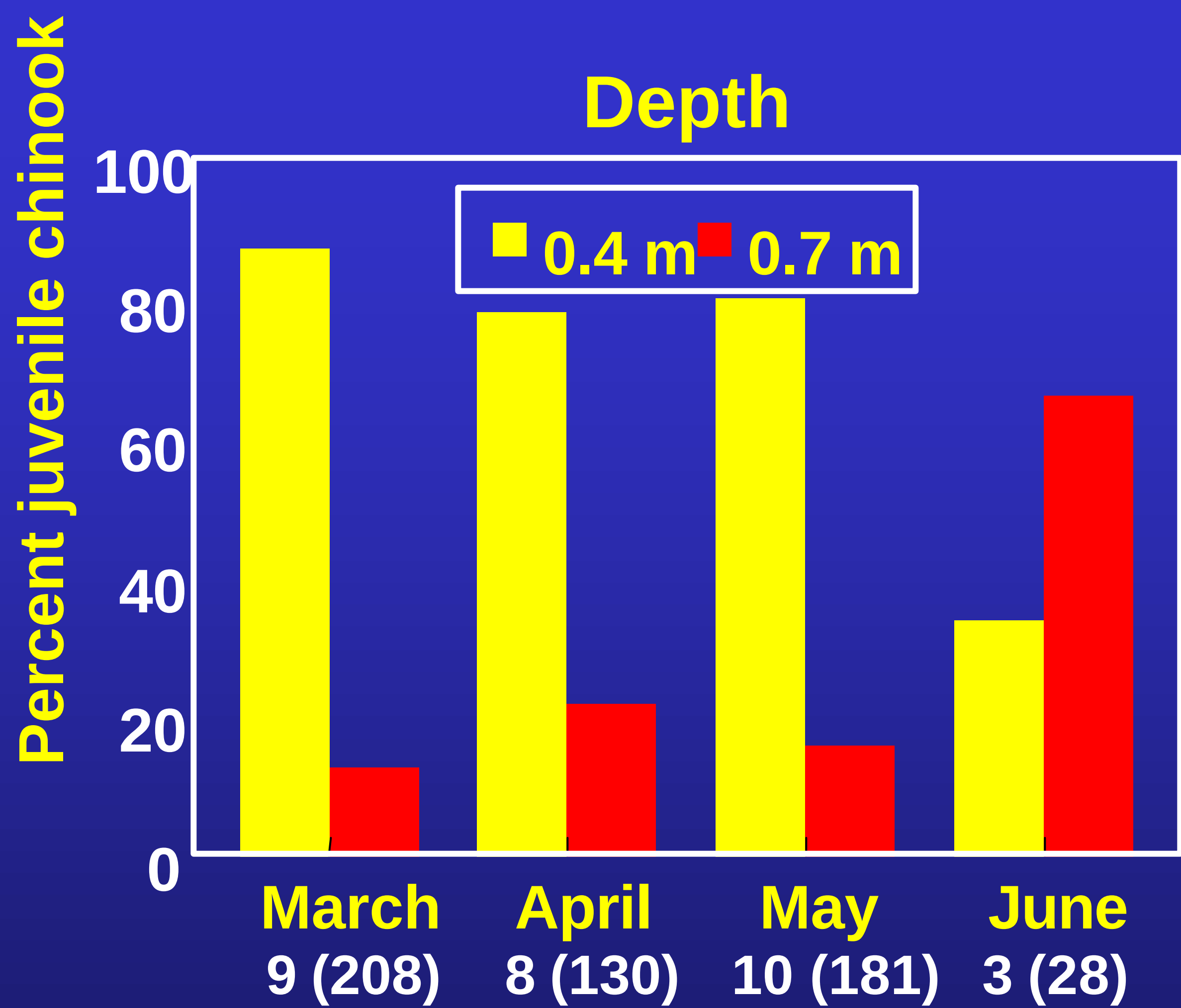


Figure 1. Distribution of juvenile chinook along the 0.4 and 0.7 m depth contours in nearshore areas of southern Lake Washington during March-June, 2000. Numbers below each graph indicate the number of surveys and numbers in parentheses indicate the number of juvenile chinook counted during each month.

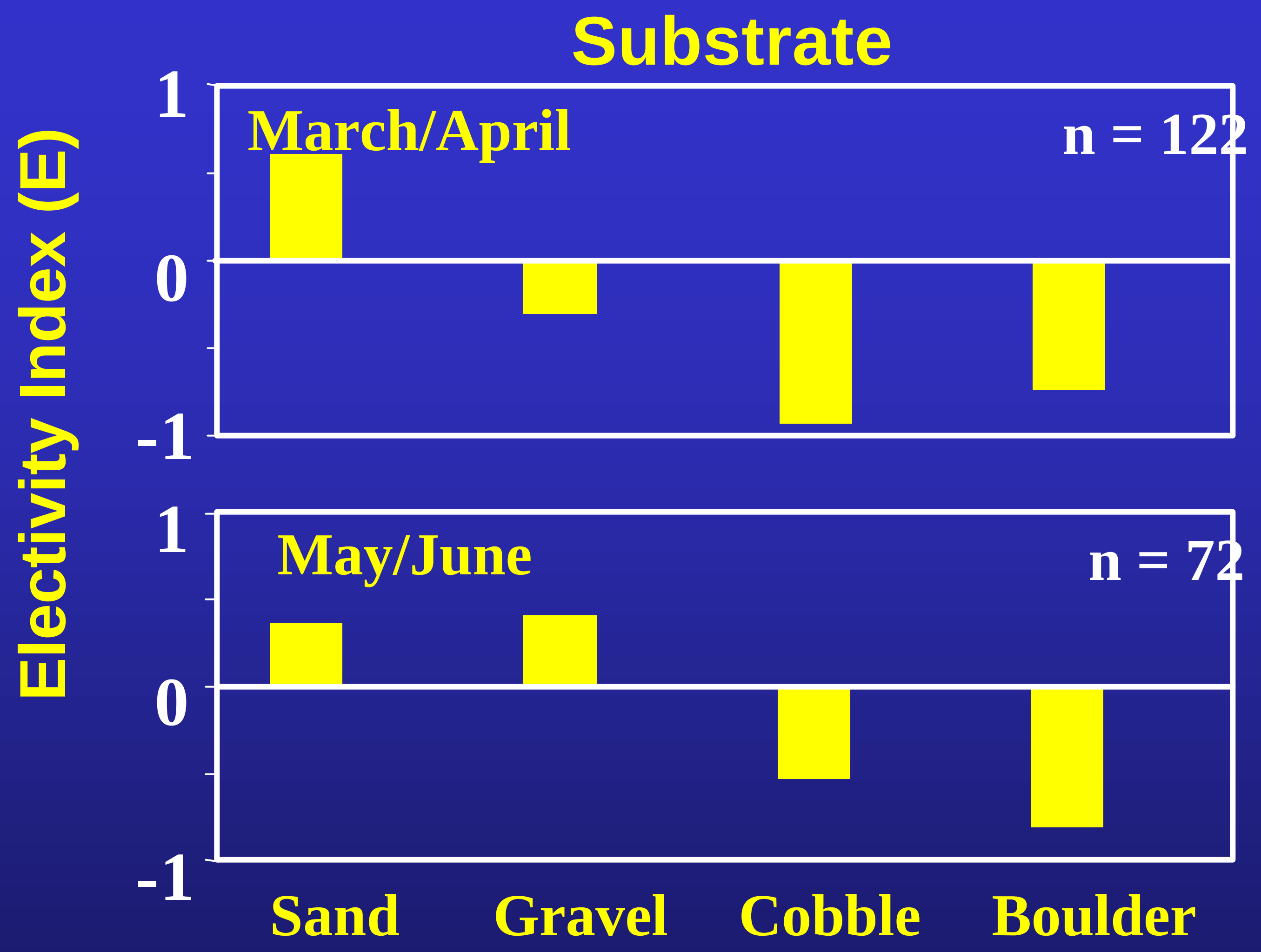


Figure 2. Electivity index values (E; Vanderploeg and Scavia 1979) for substrate use by juvenile chinook in nearshore areas of South Lake Washington during March/April and May/June, 2000 (sand: <5 mm; gravel: 5-49 mm; cobble: 50-249 mm; boulder: >249 mm). Positive index values indicate a preference and negative values an avoidance of each substrate category. Numbers in the upper right corner of each graph show the number of chinook measured for substrate use.

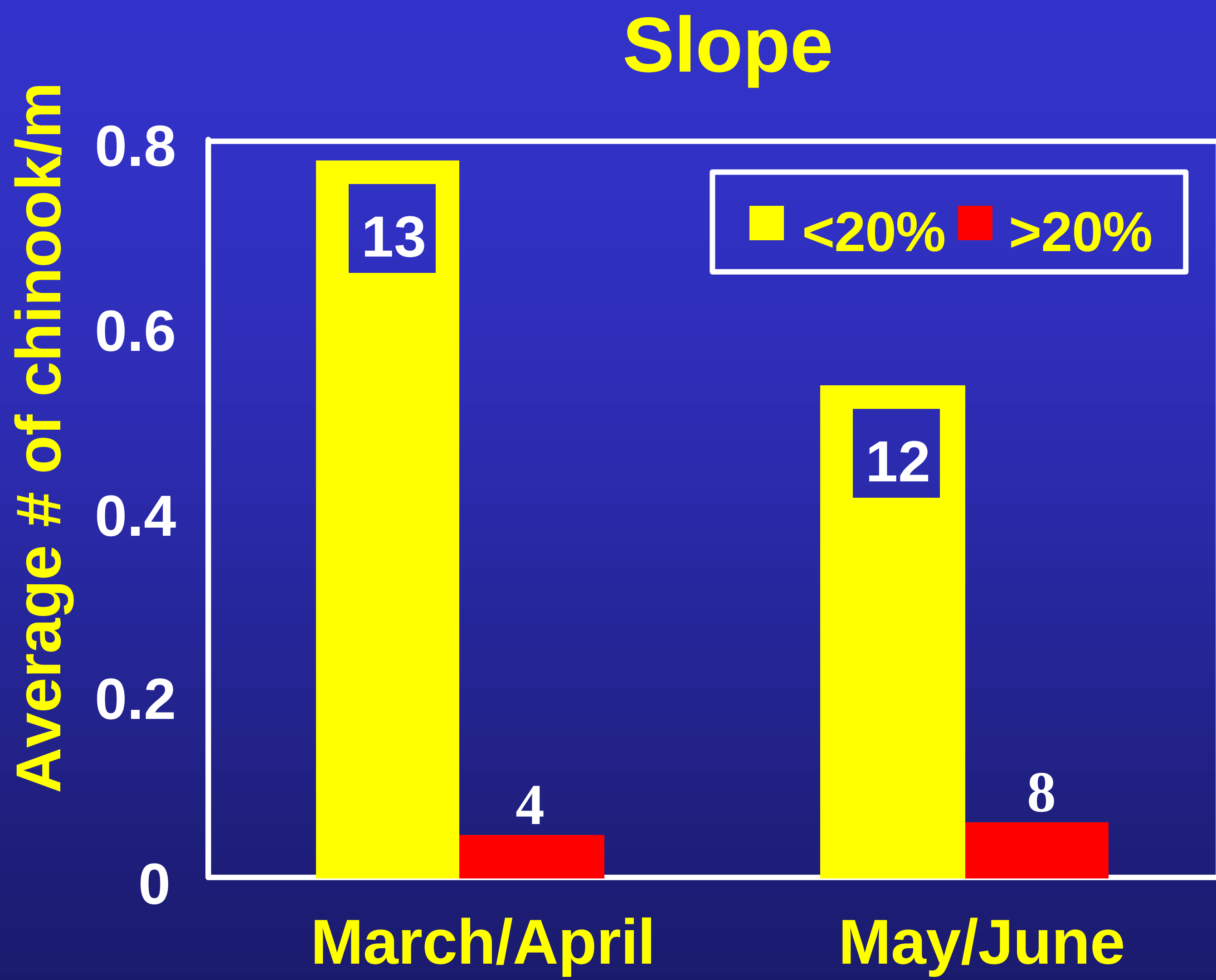


Figure 3. Average density of juvenile chinook at nearshore survey sites in South Lake Washington having less than or greater than 20% slope during March/April and May/June, 2000. Numbers within or above each bar indicate the number of surveys conducted during each period.

Overhead Structures

- **10%** of 10,704 m of surveyed shoreline was covered by overhead structures
  - (e.g. docks, piers, boat houses, and houses)
- **4%** (8 of 205) of chinook were observed under overhead structures

WHY chinook selecting these areas?

Possible factors:

- **Food availability**
- **Temperature – increase in growth**
- **Predator avoidance**

Lake Refugia from Predation:

- **STRUCTURALLY COMPLEX HABITAT**

  e.g. sunfish (Werner and Hall, 1988), bass

- **DIEL VERTICAL MIGRATIONS IN PELAGIC AREAS**

  e.g. sockeye fry

- **SHALLOW WATER HABITAT**

  e.g. chinook ??

Shallow Water Refuge

Example:
Chesapeake Bay Estuary
(Ruiz et al. 1993)

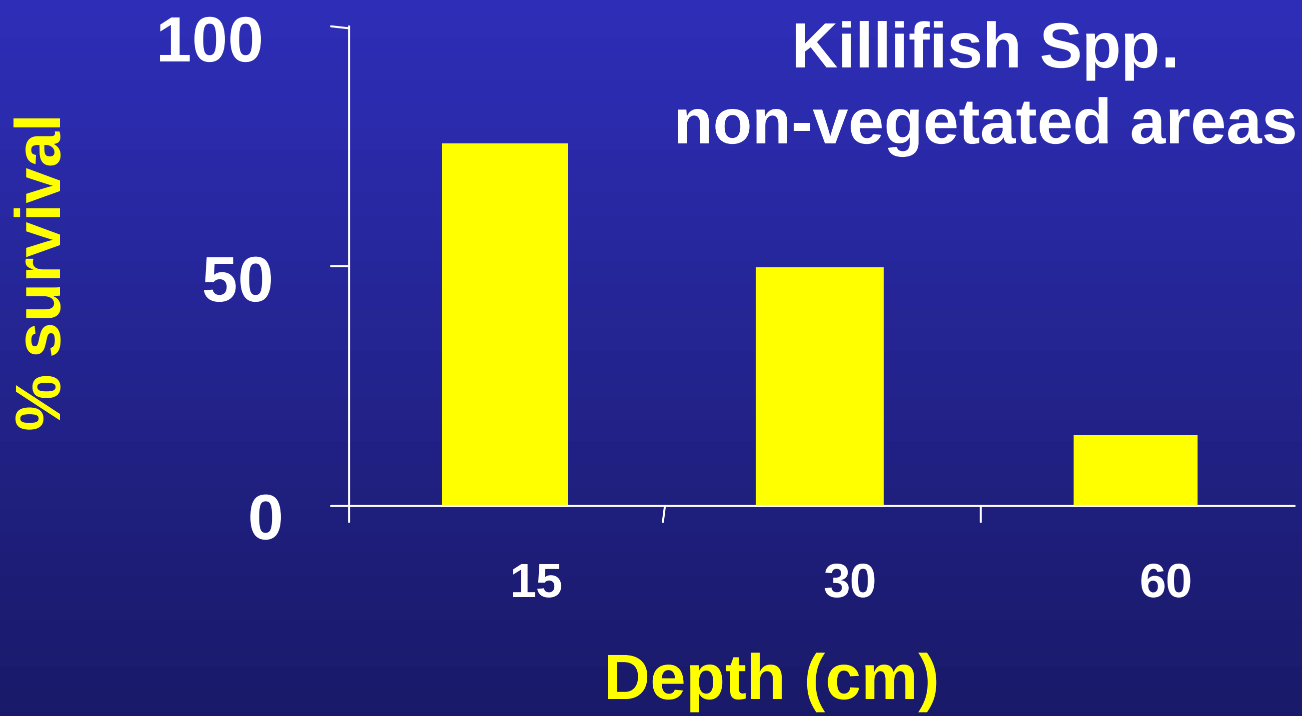


Figure 4. Relation between percent survival and water depth for Killifish species (*Fundulus* spp.) tethered at 15, 30, and 60 cm depths in a non-vegetated nearshore area of Chesapeake Bay during June, 1991. Graph recreated from Ruiz et al. (1993).

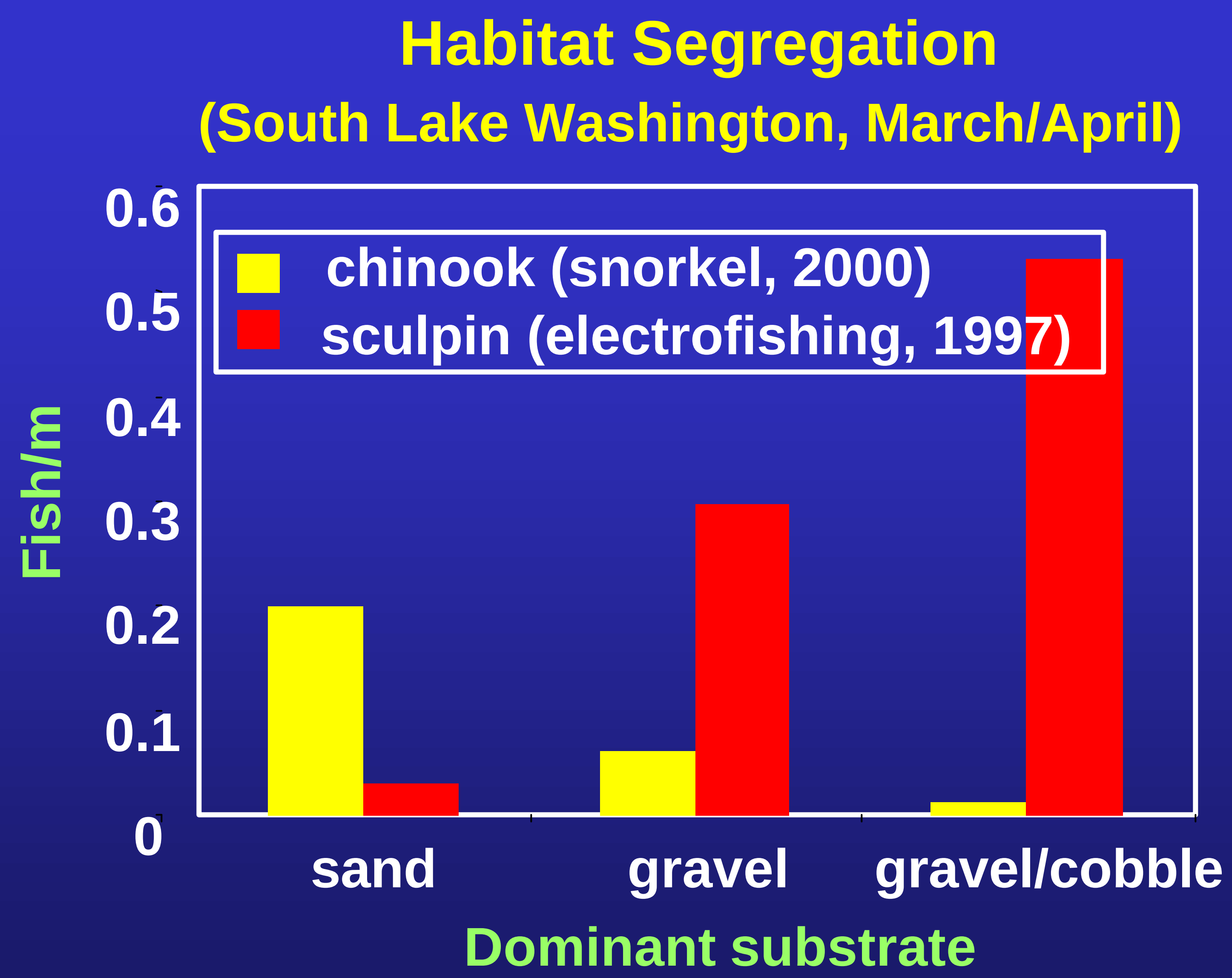
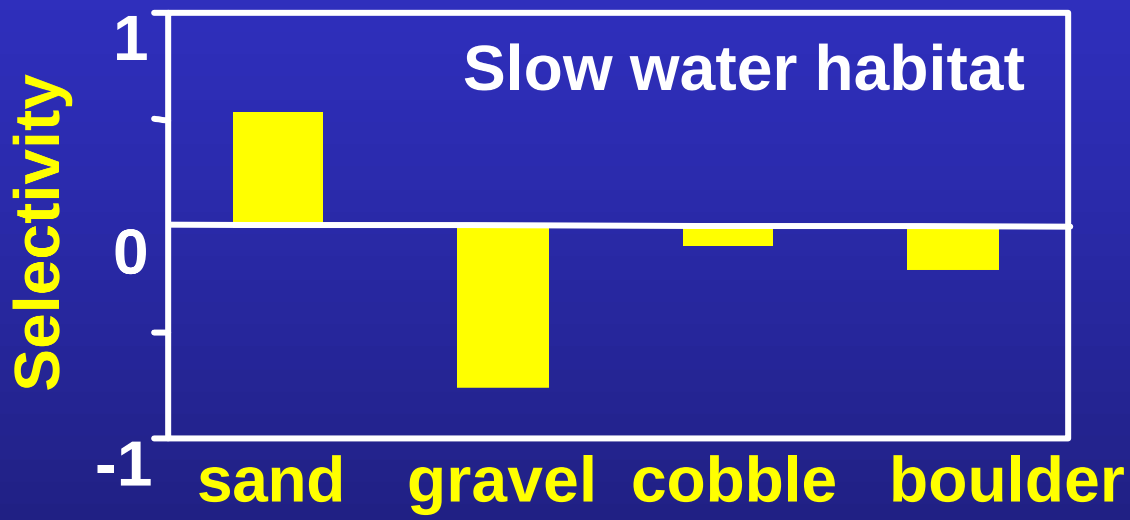


Figure 5. Density of juvenile chinook and prickly sculpin over three substrate sizes (sand: <5 mm; gravel 5-25 mm; gravel/cobble: 25-250 mm) at three nearshore locations in southern Lake Washington. Data for chinook obtained by snorkeling during this study conducted March and April, 2000. Data for sculpin obtained by electrofishing during night in March and April, 1997. Data from both studies collected at same three sites during the night.

Substrate Use by Juvenile Chinook
Hells Canyon, Snake River
(Tiffan et al. 1999)



Important predators of juvenile chinook in the Snake River include smallmouth bass and northern pikeminnow.

Figure 6. Electivity index values (Vanderploeg and Scavia 1979) for substrate use by juvenile chinook in nearshore areas of Hells Canyon Reach of the Snake River, WA during May and June, 1998 (sand: <5 mm; gravel: 5-49 mm; cobble: 50-249 mm; boulder: >249 mm). Positive index values indicate a preference and negative values an avoidance of each substrate category. Index created from data reported by Tiffan et al. (1999).

Conclusions

- Snorkeling effective in nearshore areas
- Nearshore habitat use determined by multiple factors, some interrelated
  - **Substrate:** preferred sand/gravel
  - **Slope:** preferred <20%
  - **Overhead structures:** may be avoided
  - **Theory:** Chinook use shallow nearshore areas with small substrate and little structure to avoid predators.

Additional Information Needed

Expand field surveys

- Increase sample size
  - especially the use of overhead cover
- Sample other areas of the lake
  - may include Ship Canal
- Day habitat use

Explore experimental approach options

- Manipulate overhead structure
- Monitor re-engineered sites

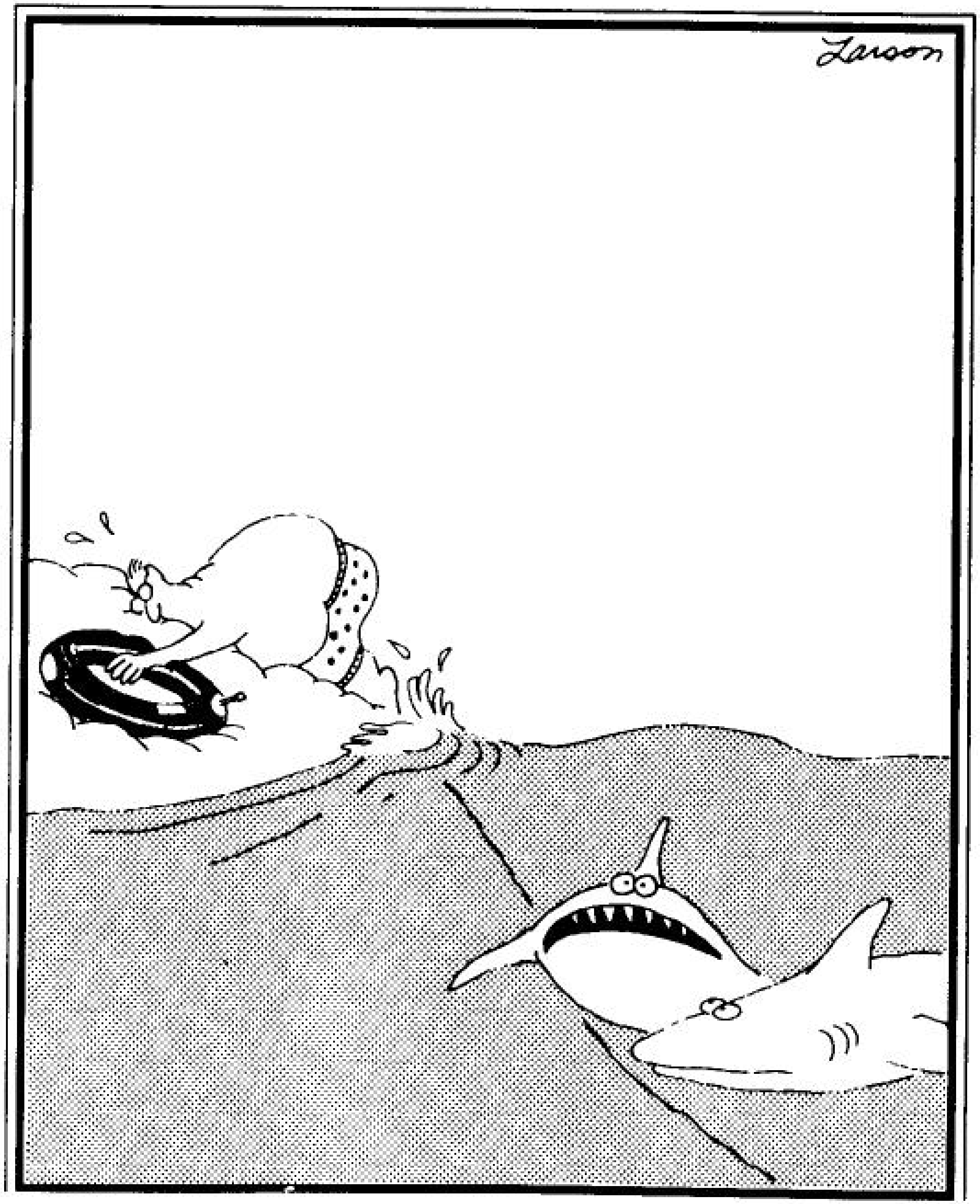
References

- Ruiz G.M., A.H. Hines, M.H. Posey. 1993. Shallow water as a refuge habitat for fish and crustaceans in non-vegetated estuaries: an example from Chesapeake Bay. Marine Ecology Progress Series 99:1-16.

- Tiffan, K.F. and three coauthors. 1999. Nearshore Habitat use by subyearling fall chinook salmon in th Snake River. Chapter four in: Post-release attributes and survival of hatchery and natural fall chinook salmon in the Snake River. Annual Report to the U.S. Dept. of Energy, Bonn. Power Admin. Project number 91-029. Contract number DE-AOI79-91BP21708.

- Vanderploeg, H.A., D. Scavia. 1979. Calculation and use of selectivity coefficients of feeding: zooplankton grazing. Ecol. Modelling 7:135-149.

- Werner, E.E., and D.J. Hall. 1988. Ontogenetic habitat shifts in bluegill: the foraging rate-predation risk trade-off. Ecology 69(5): 1352-1356.



"He was magnificent! Just magnificent! And I almost had him! . . . I can't talk about it right now."